



OVERLAPPING THE APONEUROSES IN CLOSURE OF WOUNDS OF THE ABDOMINAL WALL

INCLUDING

UMBILICAL, VENTRAL, AND INGUINAL HERNIÆ

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MY experience with the method of overlapping the aponeuroses in the closure of wounds of the abdominal wall has given such admirable results in the prevention of post-operative hernia that since 1896 I have been an enthusiastic advocate of this method of closure as applied to all wounds of the abdominal wall no matter what their location, provided drainage was not employed. As at the present time the use of this method of closure of abdominal wounds is becoming more general, it may prove of interest if I give the development of the method in my own practice and also in the hands of others.

An article by Dr. Kenelm Winslow appearing in the February, 1904, number of the *Annals of Surgery*, entitled "The Aponeuroses the Supporting Structures of the Abdominal Wall; their Approximation for the Prevention and Cure of Herniæ," has stimulated me to write this paper, although pressure of other duties has delayed its appearance. After discussing the employment of the principle of overlapping the aponeuroses in the cure of hernia, Winslow advocates, as a novel proposition, the adoption of the same principle as a routine procedure in the closure of ordinary cœliotomy wounds which theoretically he states should lead to improved results. This article shows that all general surgeons are not informed concerning the development of the operation of overlapping

the aponeuroses in the closure of wounds of the abdominal wall and the results secured by it and indicates that an additional contribution to the subject may be of real value at this time.

Prior to May, 1892, I had employed the through-and-through silkworm-gut suture in the closure of cœliotomy wounds. The high percentage of hernia following this method, especially in fat women, led me to abandon the method in favor of the tier suture. Following the principle of Schede, of Hamburg,¹ and Edebohls, I adopted the use of the buried permanent suture. Schede began the use of the buried silver wire suture in May, 1887, more especially in the cure of large herniæ. The general surgical and the gynecological departments of the Johns Hopkins Hospital also had made extensive use of silver wire as a buried permanent suture. Edebohls² first employed silkworm-gut as a permanent buried suture in June, 1891, in the cure of a large umbilical hernia, and in May, 1892, he adopted the tier suture as a routine procedure, burying one row of silkworm-gut at the plane of the aponeurosis and then closing the skin and fat with a superficial row. I adopted Edebohls' technique and used it with but few changes until the end of 1896 for all wounds of the abdominal wall, including the Alexander operation, inguinal hernia, and nephrorrhaphy. The changes consisted in substituting light for heavy silkworm-gut and in closing the subcutaneous fat and skin with catgut. The results secured by this method were eminently satisfactory as to primary wound healing, the prevention of hernia, and the absence of late irritation from the buried sutures, none of which gave trouble.^{3 4}

In spite of this satisfactory experience, several considerations induced me to abandon the Edebohls technique and to devise the method of overlapping the aponeuroses as a routine operation. These considerations were: First, the advantages of closing the peritoneum with a running catgut suture; second, the advantages of a mattress suture in relieving tension; and third, that by special preparation of the

aponeuroses and the overlapping of these structures a surface-to-surface union of the aponeuroses could be substituted for an edge-to-edge union, which promised to add materially to the strength of the resulting cicatrix. The advantages of the mattress suture and the overlapping of the aponeuroses first became apparent to me in operating for a large umbilical hernia in a stout woman April 7, 1894. Mattress sutures were introduced primarily for the purpose of taking off tension from those introduced in accordance with the Edebohls technique, but it was evident to me that an additional advantage was gained in the extent of surface of the aponeuroses which was brought into apposition. The method was used occasionally from that date until it was adopted as a routine procedure at the end of 1896, especially in cases in which considerable tension was to be overcome.

It is now so generally accepted that the chief strength of the abdominal wall as a supporting structure depends upon the aponeuroses that we will not take time in demonstrating this proposition. It is equally accepted that the chief cause of postoperative ventral hernia is defective union of the aponeuroses, leading to separation of the edges of the aponeuroses and the development of hernia. The question which presented itself to my mind was whether an improvement could be made in securing aponeurotic union over that obtained by the methods in use in 1896. I had used the tier suture after the Edebohls technique with interrupted silkworm-gut suture, and was familiar with his later technique involving the use of the continuous catgut suture.⁵ It was clear to me that the aponeurotic union secured by these methods consisted in a scar of about one line in thickness between the divided edges of the aponeuroses, provided accurate union through out the length of the wound was secured. It seemed to me that a much stronger union could be obtained by substituting a surface-to-surface union for an edge-to-edge union, therefore the method was devised and after various changes is now carried out as follows for cœliotomy wounds:

The incision in the hypogastrium for operations on the female pelvic organs may be taken as the type. This incision is made by choice through the inner border of the right rectus muscle. In closing the wound the peritoneum is first closed with a continuous suture of fine cumol catgut. The fat is then dissected from the upper surface of the aponeurosis of the transverse muscles on the left side of the wound from one-third to one-half inch. The aponeurosis upon the right side of the wound is then separated for an equal distance from the rectus muscle. The muscles and fasciæ are then sutured by means of a medium weight chromicized catgut suture in the following manner: the suturing is begun at the lower angle of the wound upon the left side. The suture is passed from above downward through the aponeurosis and rectus muscle. Then the separated bundles of the rectus muscle are united with a continuous suture until the upper angle of the wound is reached, when the suture is passed from below upward through the aponeurosis upon the right side of the wound, and an additional suture is taken above this point to fix the suture and take the strain off that part which has brought the muscle in apposition. The aponeurosis is then closed from above downward by catching the aponeurosis from the left side of the wound after the manner of the Lembert intestinal suture, and then passing the needle from below upward through the aponeurosis upon the right side of the wound. When this suture is drawn taut, it slides the aponeurosis of the right side of the wound upon the aponeurosis on the left side of the wound. The process is repeated until the lower angle is reached, when the two ends of the suture are tied. In long wounds two or more mattress sutures are placed to take tension off the lines of continuous suture. The fat is closed with a continuous suture of fine cumol catgut. The skin is closed with fine cumol catgut suture by the intracuticular method. When median wounds are long, extending near or above the umbilicus, care is taken to unite the posterior aponeurotic sheath of the rectus muscle with the peritoneum.⁶

The method was at once used for all wounds of the abdominal wall, including herniotomy wounds, modifying slightly the operation in accordance with the anatomical conditions to be dealt with. In the beginning mattress sutures of silkworm-gut were used to close the aponeurosis. Since introducing the method I have used it constantly, modifying the details somewhat, but never the principle involved.

In 1898 silkworm-gut mattress sutures were abandoned and a continuous chromicized catgut suture for the rectus muscle and for the aponeuroses was substituted.⁷ With the adoption of catgut it became feasible to make some further improvements in the method. Care was taken to suture the posterior sheath of the rectus muscle together with the peritoneum when the median incision was high enough to divide that structure. In operating for appendicitis the incision through the outer border of the rectus muscle was adopted, and a fine chromicized catgut suture was employed to close the posterior sheath of the rectus together with the peritoneum. In this way not only the anterior but the posterior aponeuroses were carefully united. The same method of suturing was employed for inguinal hernia and for Alexander operations.^{8 9}

Having traced the development of the method of overlapping the aponeuroses in its general aspects a reference to some of its special applications is in order. My original paper, "A New Method of Suturing the Abdominal Wall in Coeliotomy" (1897), opens with the following paragraph: "I desire to report a new method of closing the wound in coeliotomy, which I believe will give good results in all cases, and will enable the surgeon to deal successfully with cases of diastasis of the recti muscles, which heretofore have been most difficult to cure."

Since that time the method had been employed repeatedly for the cure of diastasis of the recti, and so far as is known in no case had there been a recurrence or the development of a ventral hernia. I am satisfied that the method by overlapping the aponeuroses will give better results than that proposed by Webster in 1900.¹⁰

In the cure of herniæ the method of overlapping the aponeuroses is especially important and valuable. As already stated, it was first employed by myself in the closure of an umbilical hernia in 1894. Since that time the method has been employed in almost all operations for hernia, whether umbilical, ventral, or inguinal. In operations for umbilical hernia at times there is less tension when the aponeurosis is overlapped from above downward instead of from side to side. If good surface-to-surface aponeurotic union can be secured a permanent cure will be effected even though the recti muscles remain separated. I first made use of the plan of overlapping the aponeuroses from above downward February 14, 1898. In this case it was impossible to approximate the recti, and as there was far less tension from above downward than laterally the transverse suture was adopted. This method of operating upon umbilical hernia has been largely employed by W. J. Mayo,¹¹ who first reported upon its use in 1898. In this paper, after describing the method of overlapping which he had employed, he states that it was similar to my method of closing coeliotomy incisions. Since that time Mayo has made two further reports upon the cure of umbilical hernia by overlapping the fasciæ, and has especially recommended the overlapping from above downward.^{12 13}

The principle of overlapping the aponeurosis in the cure of inguinal hernia was first applied by Lucas-Championnière in 1892 or earlier.¹⁴ In 1901, in his brochure on the radical cure of inguinal hernia,¹⁵ he reported a series of seven hundred and fifty-nine operations. It is not necessary in this connection to discuss the methods used by Championnière in dealing with the sac and the inguinal canal itself. The question of particular interest is his method of dealing with the aponeurosis. He devised what he calls a U-shaped suture, which is a modified mattress suture, by means of which he overlapped the outer segment of the aponeurosis upon the inner segment, and then by means of interrupted sutures made the approximation neat. I can find no indication

that Championnière employed the principle of overlapping the aponeuroses otherwise than in the cure of inguinal hernia, and must therefore conclude that he failed to appreciate its value in the closure of *cœliotomy* wounds in general. The method of suturing which he used accomplishes the overlapping of the aponeurosis very satisfactorily, but it is much more complicated and more tedious in its application than the method which I have devised.

E. Wyllys Andrews was the next surgeon to make use of the principle of overlapping the aponeurosis in the cure of inguinal hernia. He called the method which he devised the "imbrication or lap-joint method."¹⁶ He refers to the work of Championnière, which he regards merely as an improvement of the usual method of closing the inguinal canal. His own operation accomplishes two purposes: first, the overlapping of the aponeurosis; and second, the transplantation of the cord into an artificial canal. He sutures the inner layer of the aponeurosis to Poupart's ligament behind the cord. The outer layer of the aponeurosis is then sutured above the cord to the inner layer. From the standpoint of the more general use of the principle of overlapping the aponeuroses, Andrews' article is of special interest, as he states that "the principle of imbrication or overlapping the several aponeurotic layers of the abdominal wall may enter into other abdominal operations to advantage, as I have repeatedly shown." In a second article on the radical cure of hernia,¹⁷ in 1897, after discussing his own and other methods for the cure of inguinal hernia, he concludes with the following:

"I cannot refrain from stating that I have found the principle of imbrication applicable to other purposes, such as uniting abdominal wounds after ordinary *cœliotomy* near the *linea alba* and *linea semilunaris*, but in this part of the subject I cannot hope to interest you at the present time."

It is thus evident that Andrews appreciated the value of the principle in suturing all wounds of the abdominal wall, and therefore it is probable that he made more or less systematic use of it.



If this paper were a study of the development of the radical cure of inguinal hernia, it would be necessary to refer to the operations of Bassini, Halsted, and others, but with its actual limitations it is only of interest to point out that in the Johns Hopkins clinic practical experience showed the limitations of the original Halsted operation with the typical mattress suture. Bloodgood tried to meet the necessities of the case in large herniæ by transplantation of the rectus muscle and by use of the sheath of the muscle to take the place of the conjoined tendon.¹⁸ Halsted¹⁹ still later reports that in certain cases he makes a flap from the cremaster muscle, which is sutured to the under side of the internal oblique muscle. The conjoined tendon and the internal oblique are sutured to Poupart's ligament, and then the aponeurosis of the external oblique is overlapped. Halsted states that this is known as the Andrews method, although devised independently by him.

My own work in the cure of inguinal hernia has been incidental to that in abdominal surgery in general and gynecology, and I have never devoted special study to the closure of wounds of the inguinal canal, whether for inguinal hernia or the Alexander operation. In operations for inguinal hernia in women the Bassini operation has been done, with overlapping of the aponeurosis of the external oblique. In the Alexander operation the same technique has been followed, with the exception that the round ligament has been included in the sutures which unite the internal oblique to Poupart's ligament. In addition, I frequently place a mattress suture of silkworm-gut at the internal ring in hernia operations to reinforce this point—the suture entering the external oblique, passing through the internal oblique, through Poupart's ligament, and then back through the internal and external oblique. This suture is tied after the canal is closed in the usual way.

In my own work the development of the principle of overlapping the aponeuroses in the closure of wounds of the abdominal wall grew out of my experience with the other

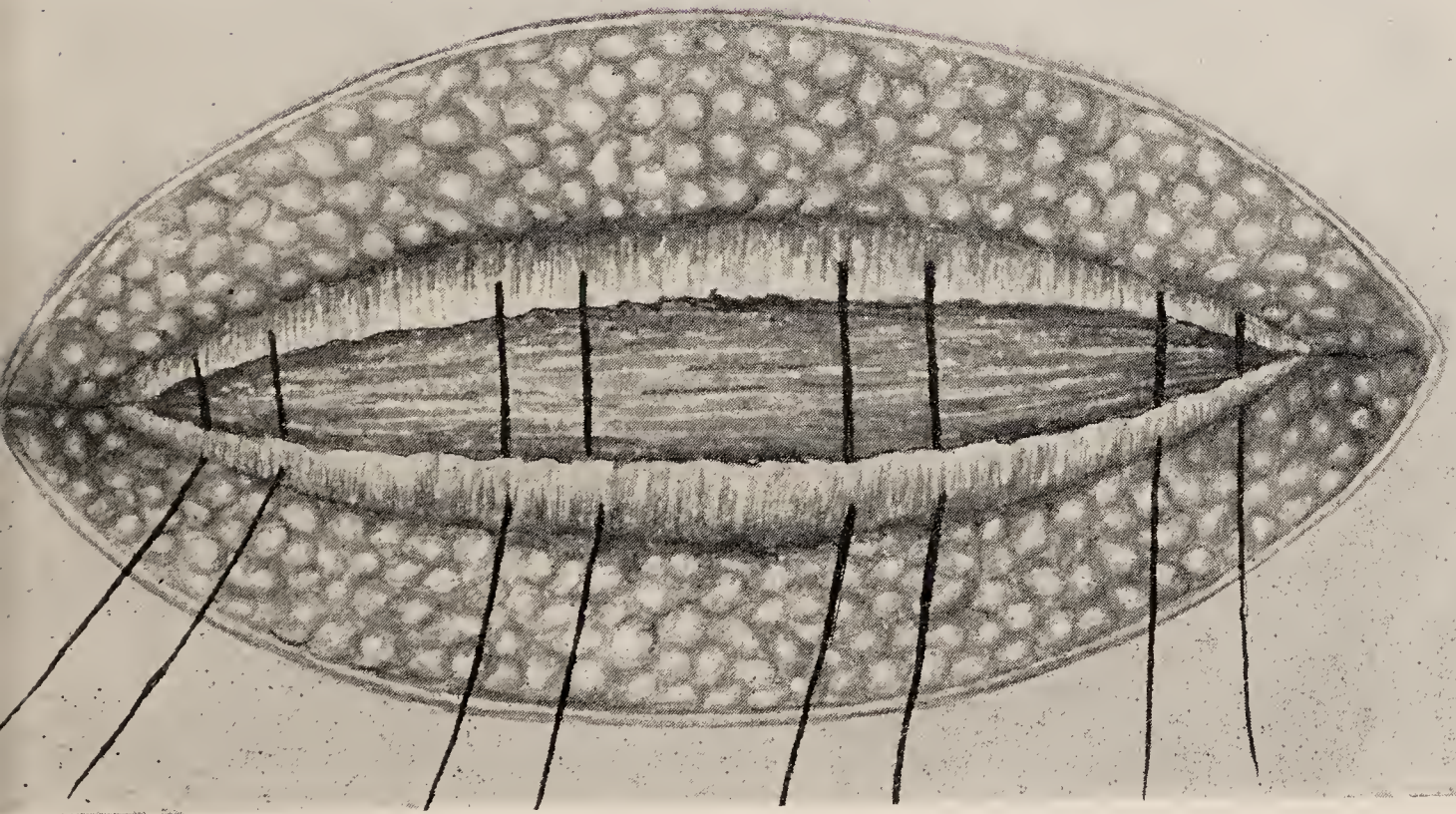
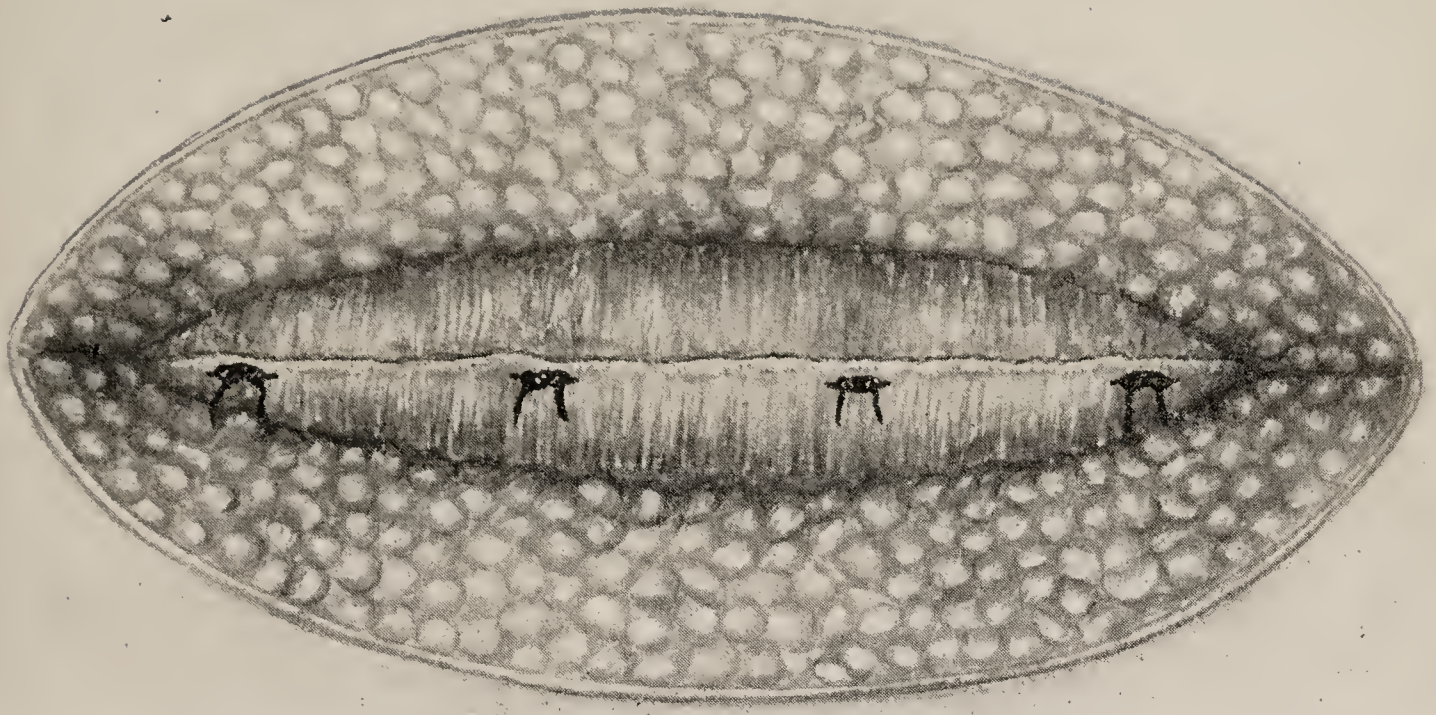
methods of closure previously used, and was the natural consequence of recognizing the shortcomings of these methods. The application of the principle to the cure of inguinal hernia, to the cure of umbilical hernia, and to the cure of diastasis of the recti muscles was a natural development from the use of the principle in the usual *cœliotomy* wound and for operations for appendicitis and for movable kidney. I was not aware of the work of Championnière and Andrews in the cure of hernia, as not being a general surgeon and having no occasion to operate for inguinal hernia in men, I had given no critical study to the special literature concerning inguinal hernia.

It is quite clear that to Championnière is due the credit of having first appreciated the advantages of overlapping the aponeuroses; apparently, however, he did not realize that the principle had any application elsewhere than in the inguinal canal. With Championnière's work as a basis, Andrews developed a special technique for the cure of inguinal hernia, and also more fully appreciated the importance of the principle, as shown by the references already given to his articles, in which he claims that the method can be applied with advantage to the usual *cœliotomy* wounds. It is evident that the process by which Andrews arrived at this opinion was exactly the reverse of my own experience. A realization of the advantages of the method in the special operation for the cure of inguinal hernia suggested its employment in all other abdominal wounds; whereas, in my own work the appreciation of the advantages of the method in the closure of abdominal wounds in general led to its employment in the special operations on the inguinal canal.

The best evidence which I can give as to the practical merit of the method in the prevention of postoperative hernia is the fact that during the nine years in which the method has been in use, but a single patient has presented herself with postoperative hernia. Others may have occurred of which I have no knowledge, but it is quite clear that postoperative hernia plays an unimportant rôle when the aponeuroses are overlapped in the closure of *cœliotomy* wounds.

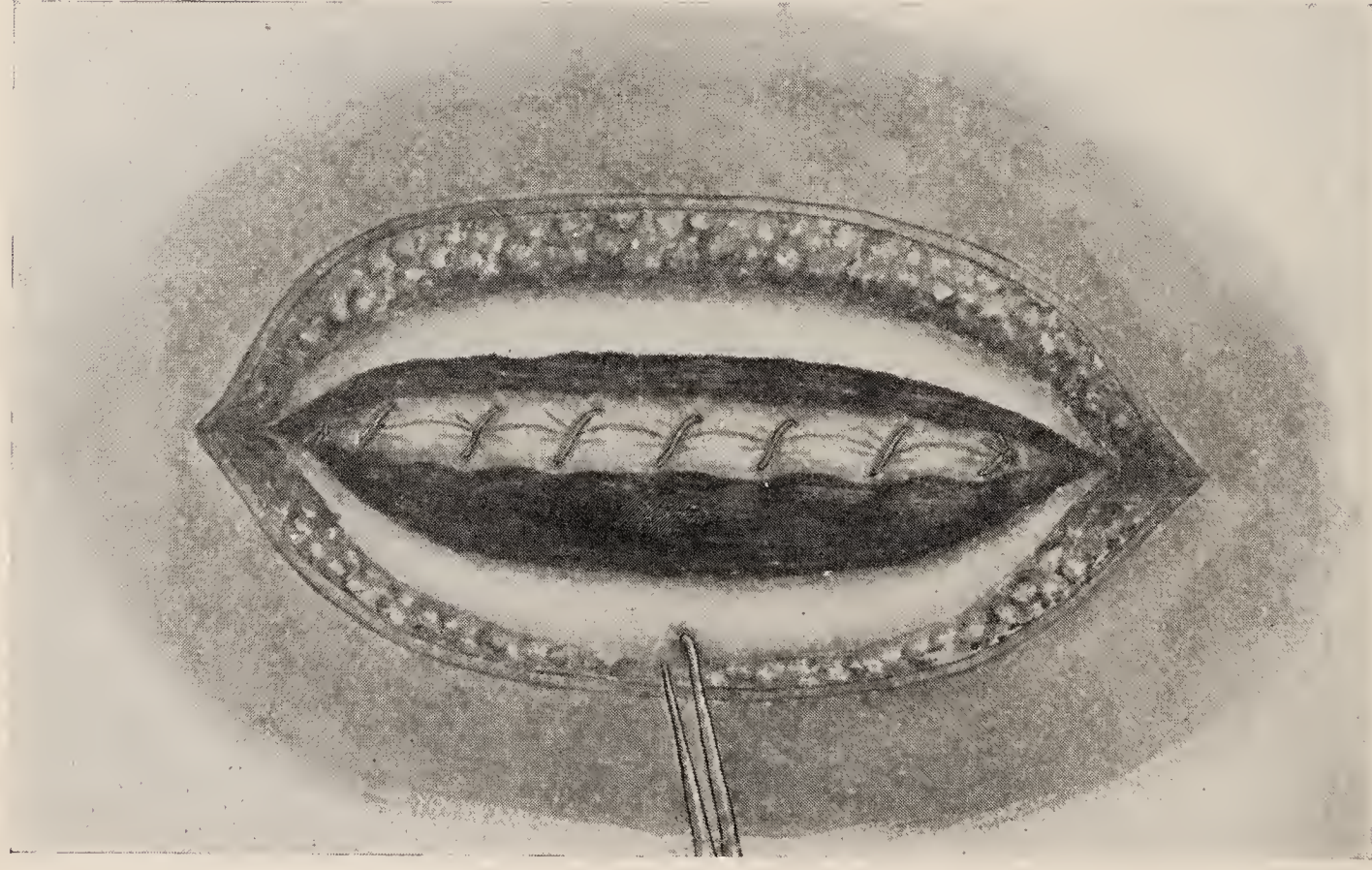
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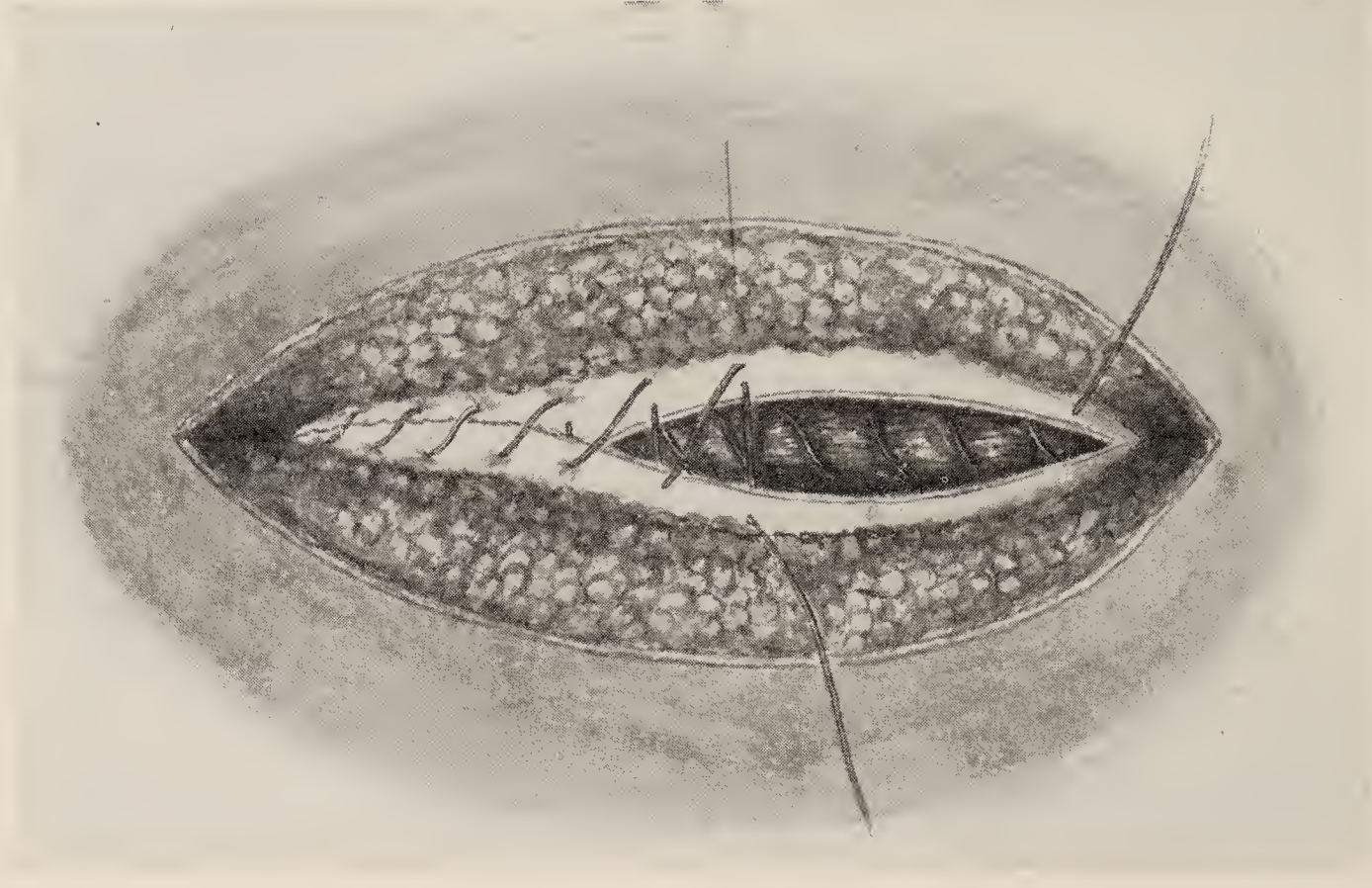
Modified mattress suture for closing the aponeurosis with silk worm gut.

FIG. 2.



Closing the abdominal wound.—1. Suture of the peritoneum with a fine running catgut suture. 2. Preparation of the aponeurosis for suturing. (a) Separation of the right aponeurosis from the rectus

FIG. 3



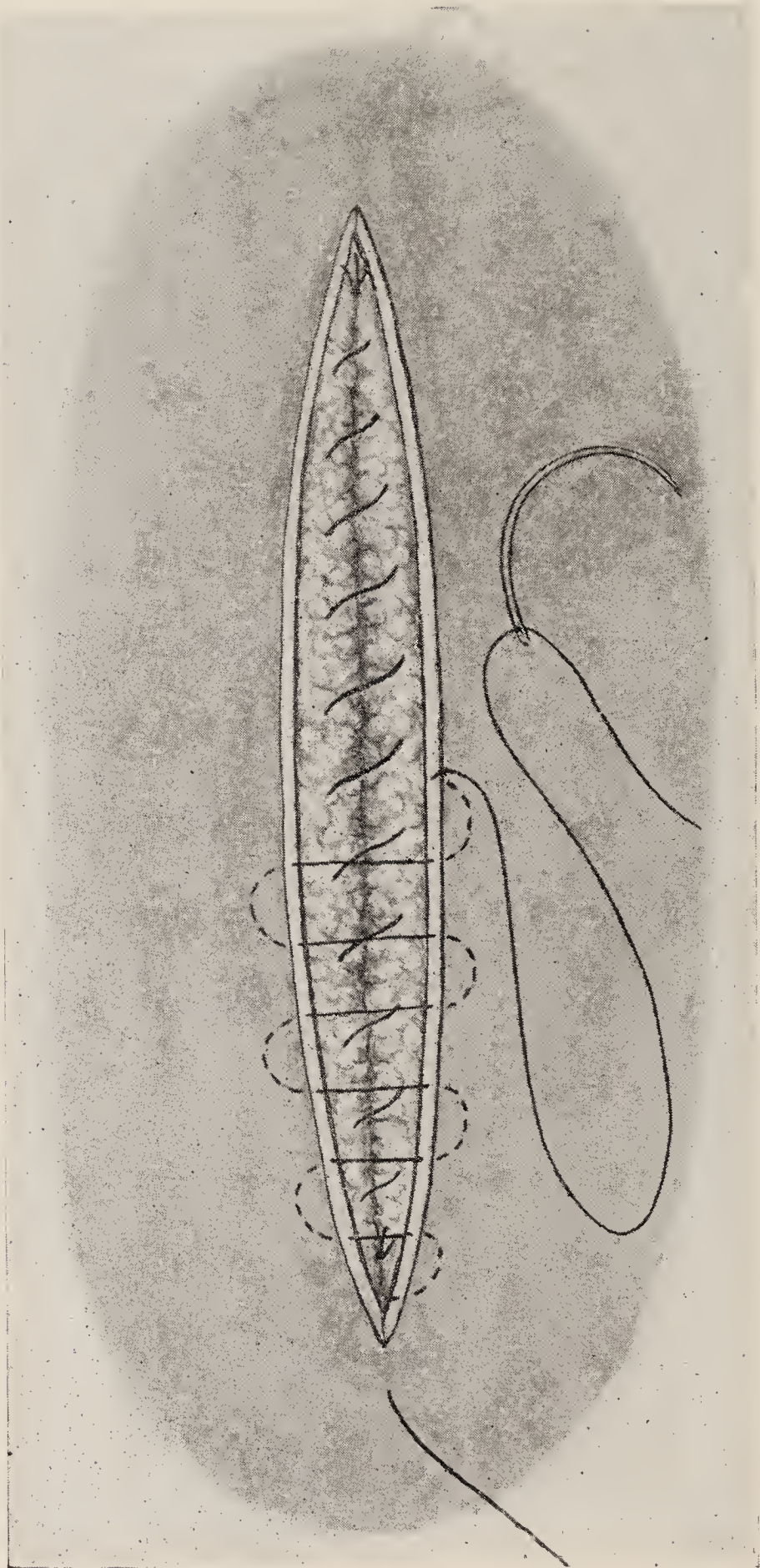
Closure of the wound in the aponeuroses of the oblique muscles. Overlapping the aponeuroses by superimposing that of the right side of the wound upon that of the left, and suturing with a continuous chromicized

FIG. 4.



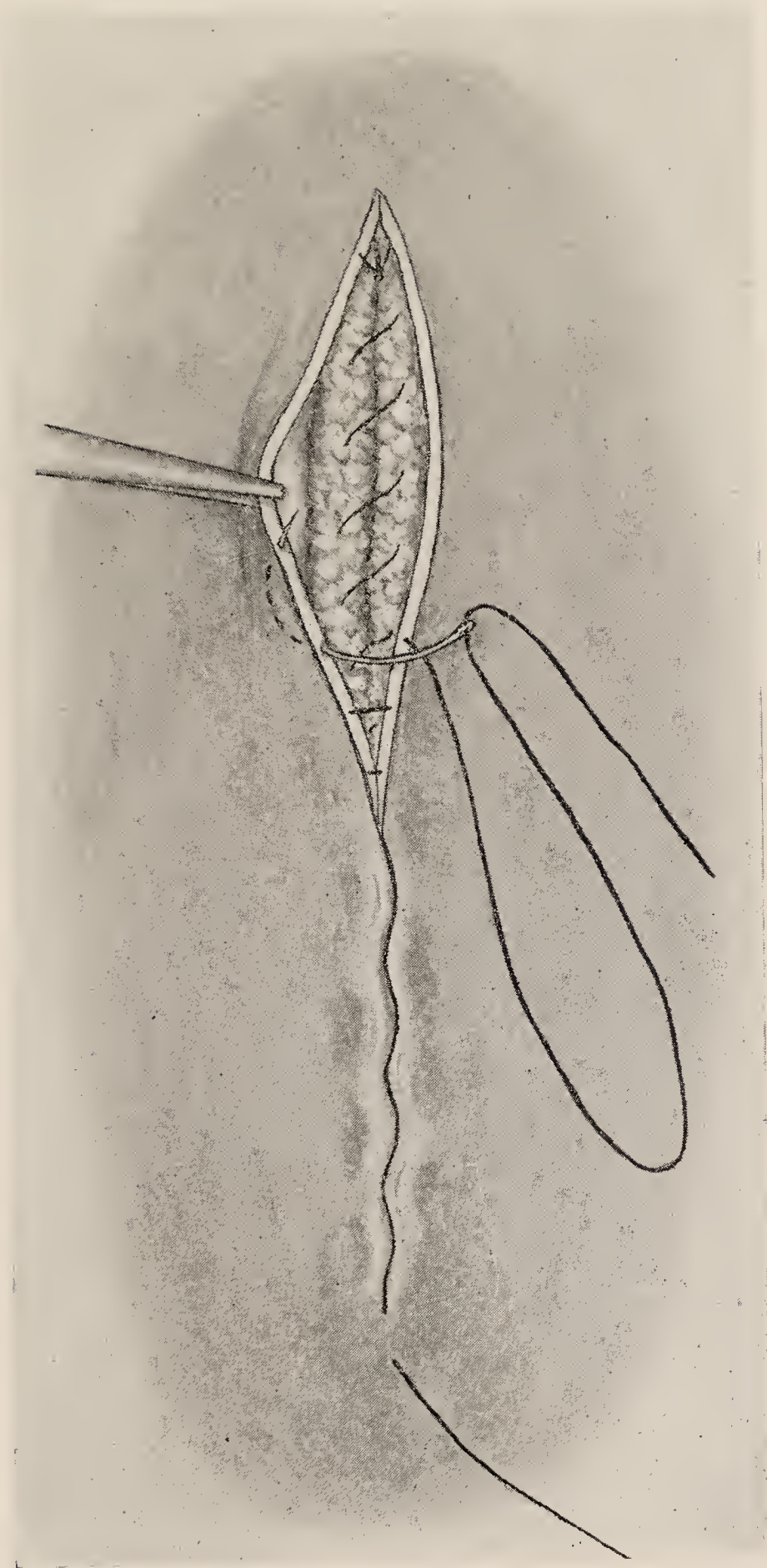
Suture of superficial fascia and fat layer.

FIG. 5.



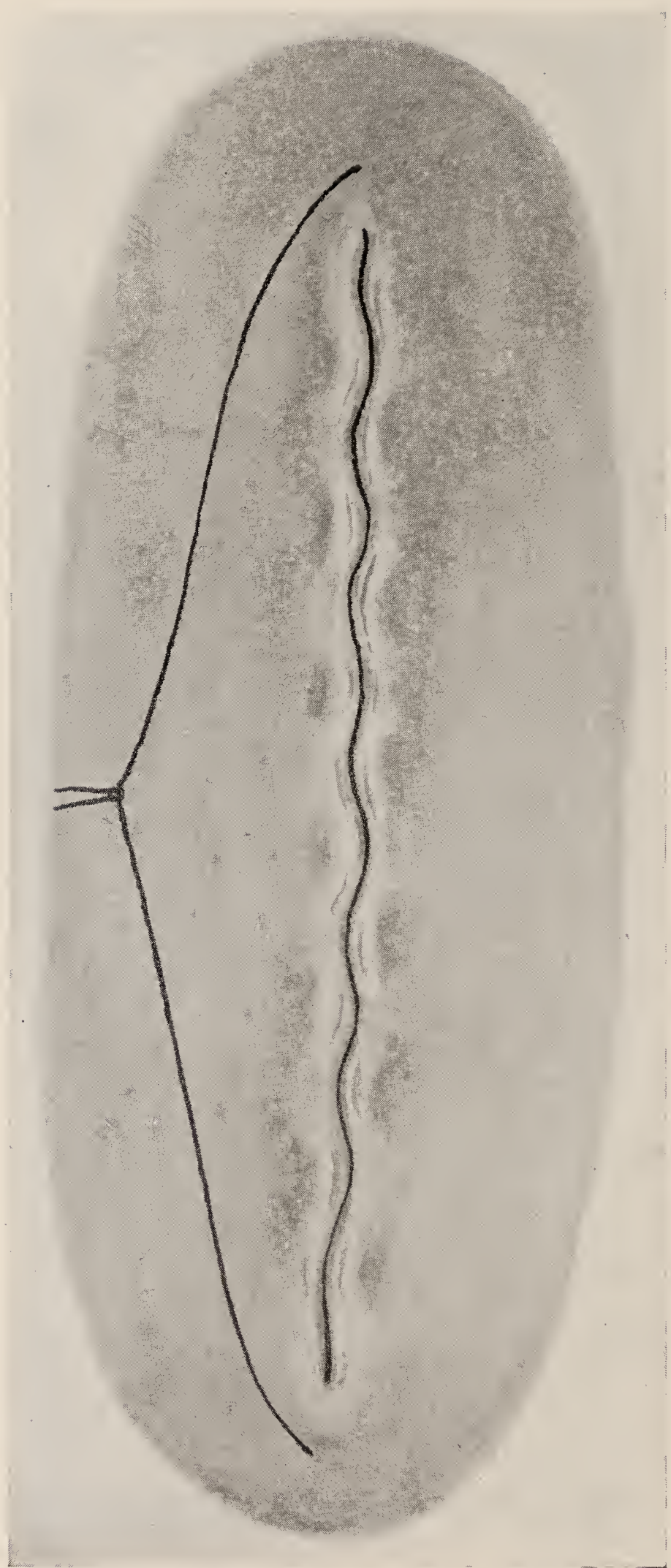
The subcuticular suture of the skin.

FIG. 6.

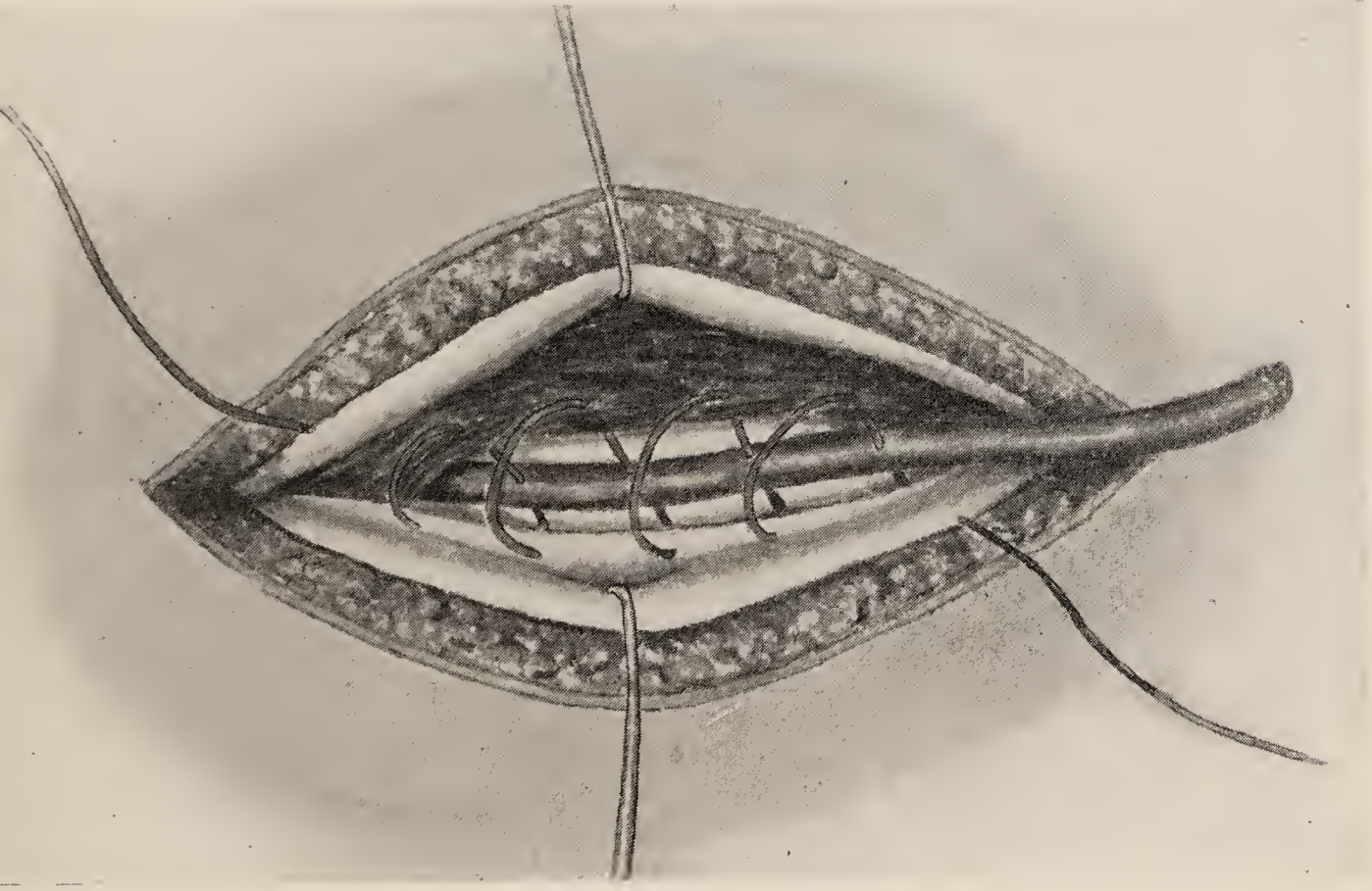


Skin wound partly closed by subcuticular suture.

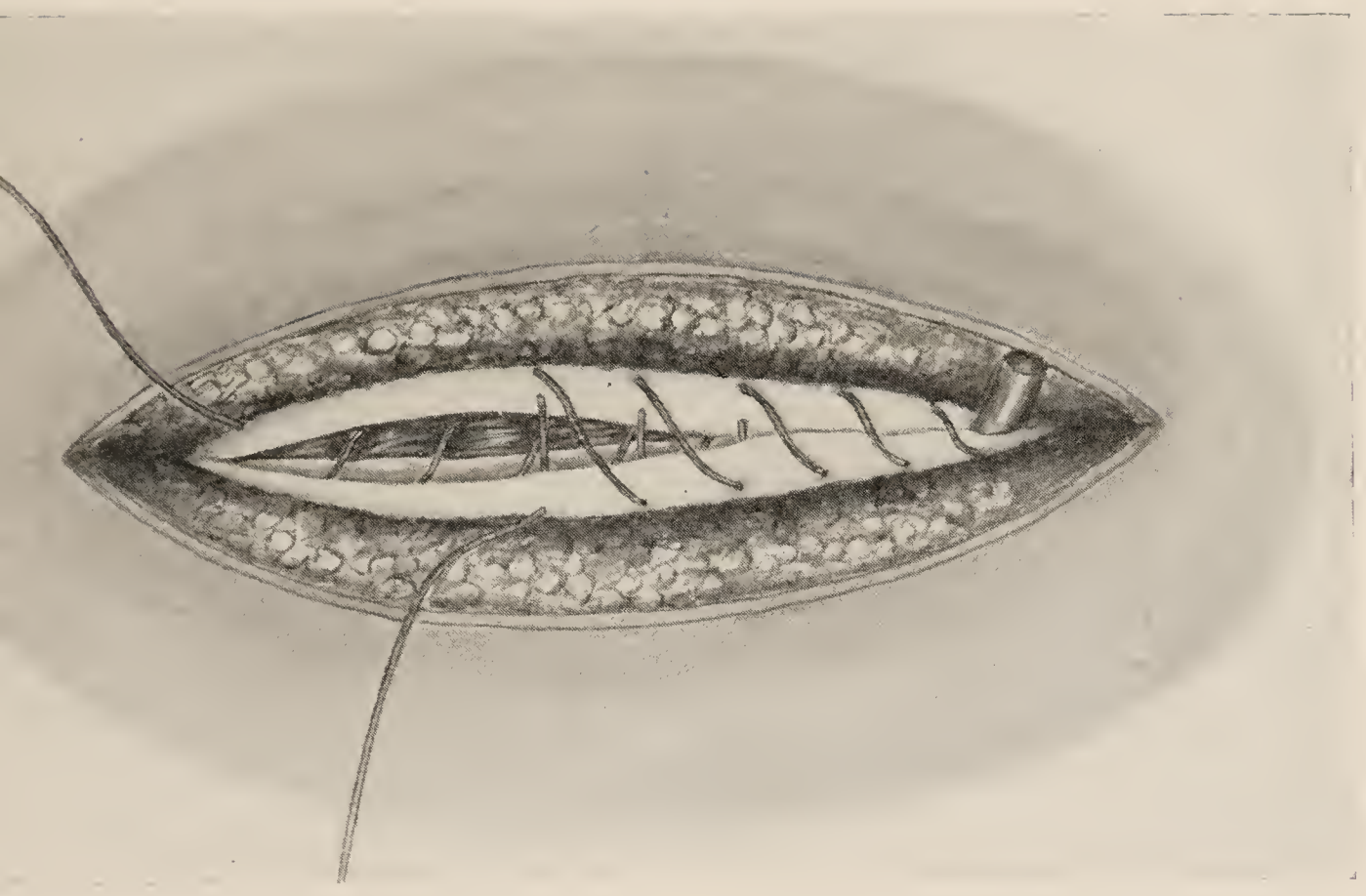
FIG. 7.



Final closure of skin wound.



Shortening the round ligaments. Suturing the internal oblique round ligaments and Poupart's ligament with chromicized catgut, to fasten the ligament and obliterate the canal.



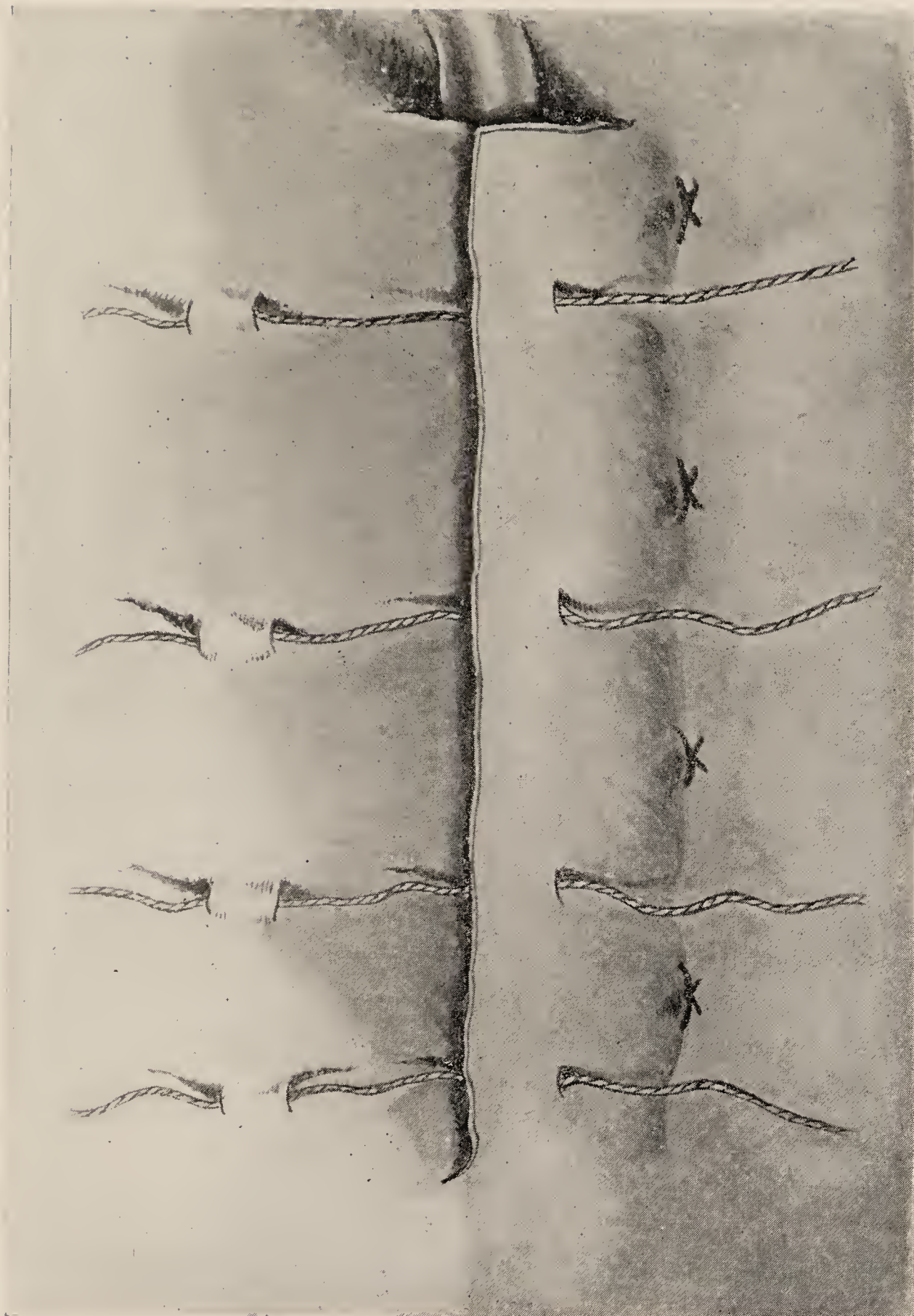
Overlapping the aponeurosis of the external oblique in closing the inguinal canal.

FIG. 10



Championnière's method of overlapping the aponeurosis of the external oblique—
inguinal hernia. Showing U-sutures, and interrupted sutures in place.

FIG. 11.



Championnière's method—showing the U-sutures tied, and the interrupted sutures in place for tying.

FIG. 12.



Andrews' imbrication or lap-joint operation for inguinal hernia.

